

S C I E N C E

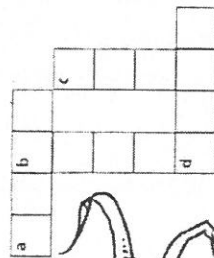
I N T R O D U C T I O N

Dinosaurs

Complete the descriptions of the four dinosaurs. Choose four words in each box and write them in the crosswords. Then write the words in the sentences. There is one extra word in each box.

1 Compsognathus

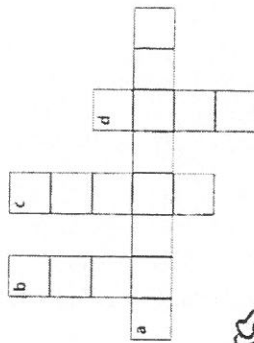
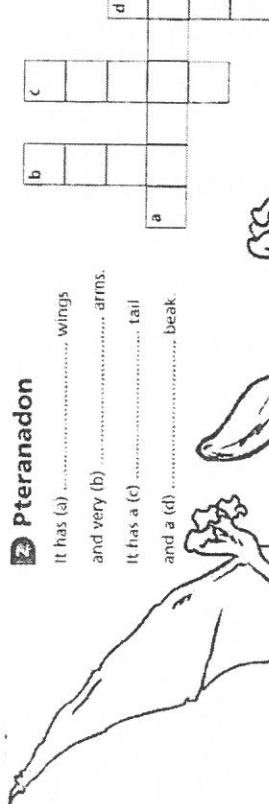
It is a (a) runner
and it is (b)
It has (c) legs
and a (d) tail



fast
thin
small
fat
long

2 Pteranodon

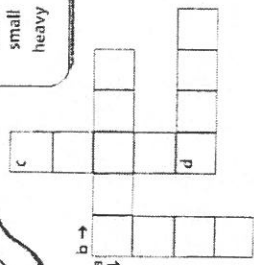
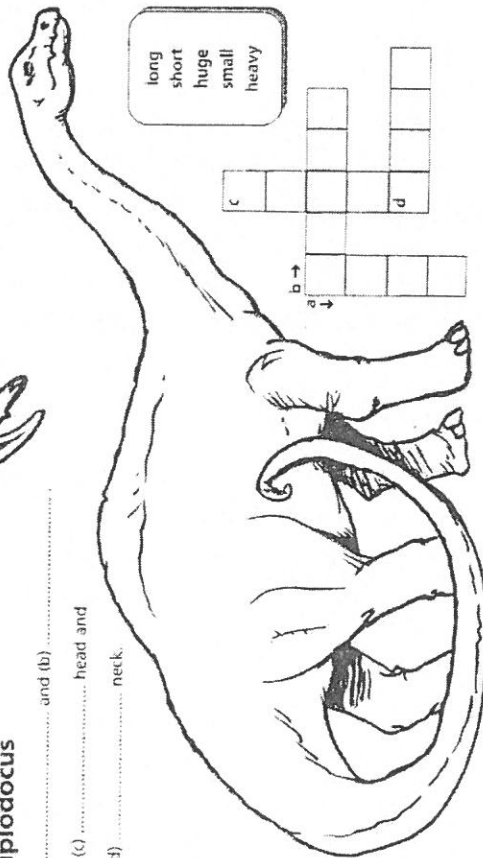
It has (a) wings
and very (b) arms.
It has a (c) tail
and a (d) beak.



small
enormous
long
thin
short

3 Diplodocus

It is (a) and (b)
It has a (c) head and
a very (d) neck.

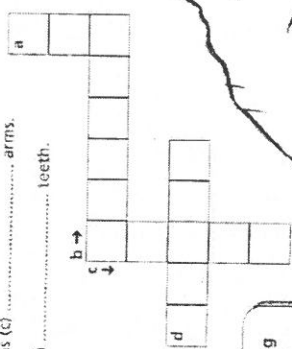
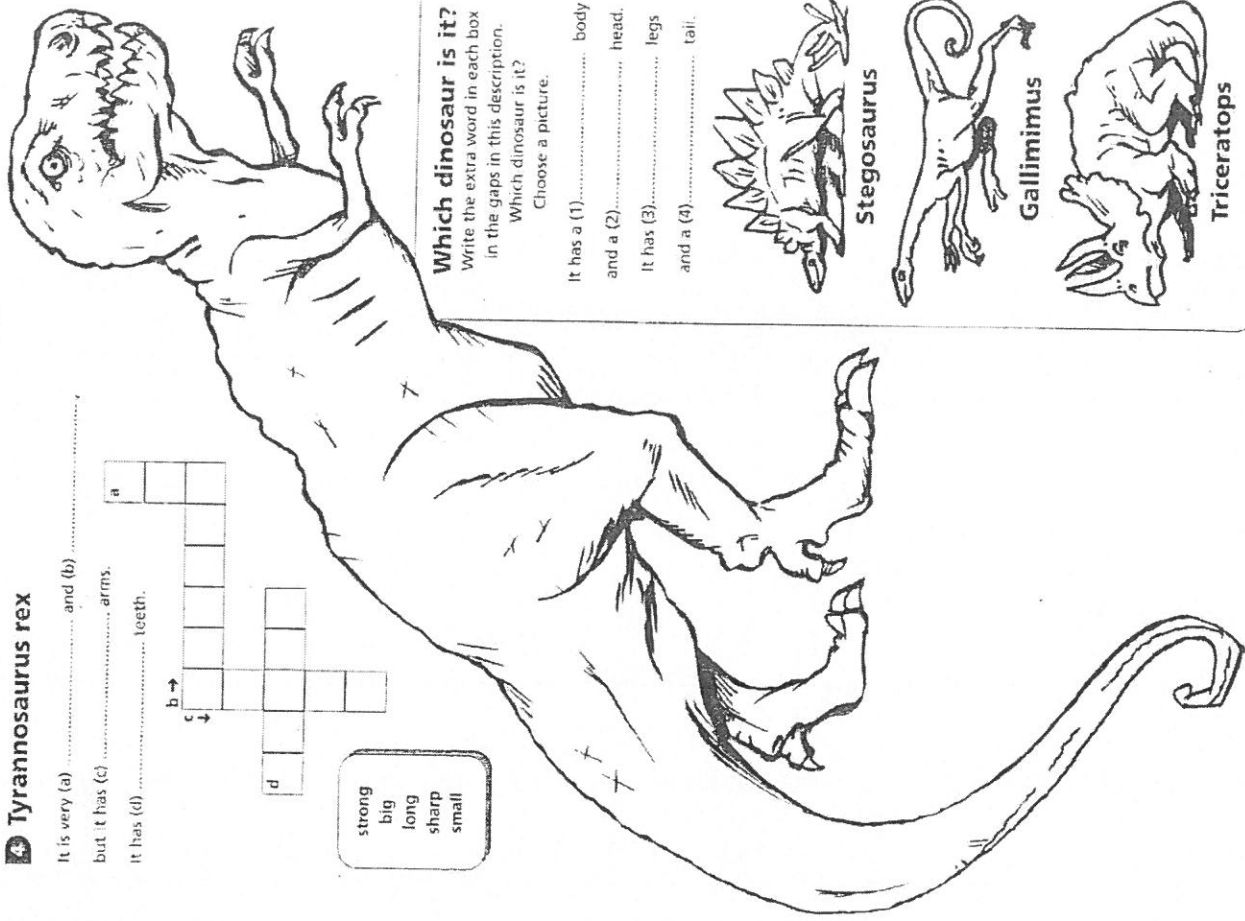


long
short
huge
small
heavy

Dinosaurs

4 Tyrannosaurus rex

It is very (a) and (b)
but it has (c) arms.
It has (d) teeth.



strong
big
long
sharp
small

Which dinosaur is it?
Write the extra word in each box
in the gaps in this description.
Which dinosaur is it?
Choose a picture.

It has a (1) body
and a (2) head.
It has (3) legs
and a (4) tail.



Stegosaurus



Gallimimus



Triceratops

Technology

Modern technology makes our lives easier and helps us to learn more about the world and the universe. Here are some of the things that we have because of technology.

Can you find the correct sentence to describe each thing?

camcorder

You can play a tune on a camcorder. (S)

You can do your maths homework with a camcorder. (L)

You can film your friends and family with a camcorder. (M)



mouse

You can choose television programmes with a mouse. (A)

You can take a photograph with a mouse. (O)

You can control your computer with a mouse. (I)

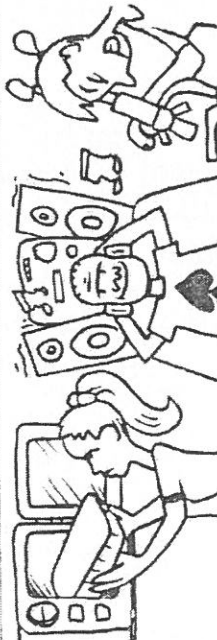


microwave

You can cook your dinner in a microwave. (C)

You can listen to music with a microwave. (V)

You can see very small objects with a microwave. (T)



shower

You can have a wash in a shower. (R)

You can watch a film at the shower. (H)

You can look at the stars with a shower. (B)



vacuum cleaner

You can clean your carpets with a vacuum cleaner. (O)

You can boil water in a vacuum cleaner. (U)

You can wash your clothes in a vacuum cleaner. (E)



Technology

credit card

You can tell the time with a credit card. (G)

You can buy things with a credit card. (C)

You can drive to school in a credit card. (N)



space shuttle

You can travel to Mars in a space shuttle. (H)

You can play games on a space shuttle. (R)

You can dry your hair with a space shuttle. (J)

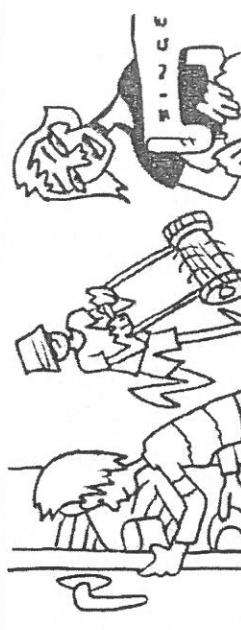


fridge

You can cut your grass with a fridge. (A)

You can make clothes with a fridge. (E)

You can keep food cold in a fridge. (I)



mobile phone

You can fly to Australia in a mobile phone. (D)

You can go for a ride on a mobile phone. (F)

You can talk to your friends on a mobile phone. (P)



Write the letters next to the answers you choose and find the name of something that is very important in modern technology.

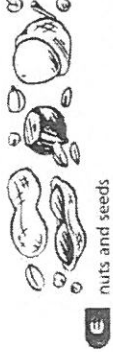
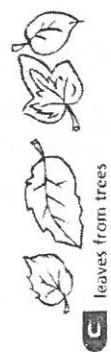
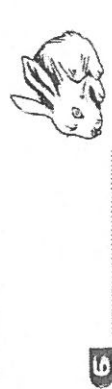
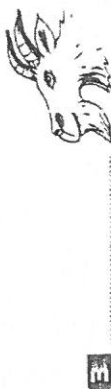
Ecosystems

What is it? What does it eat?

Write the name of each animal next to its picture. Use the words in the box.

Then match the animals with their food.

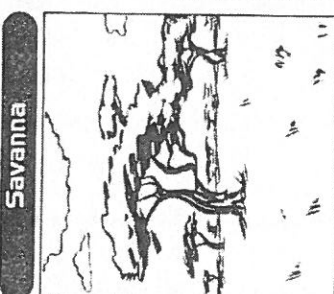
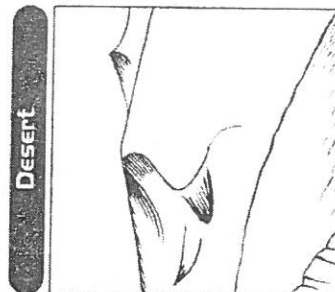
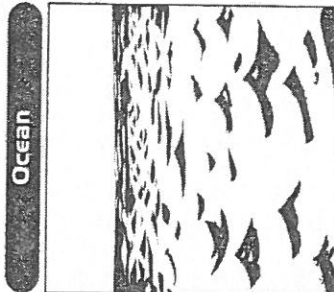
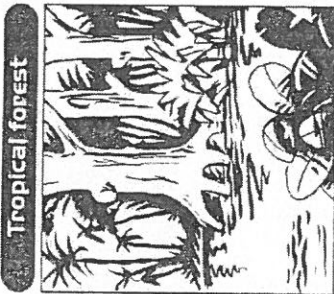
mountain goat dolphin rabbit penguin squirrel parrot alligator scorpion giraffe



Ecosystems

Where does it live?

Write the name of each animal from page 6 under the picture of its habitat.



TIMSS
Sample Elementary School
Science Test (Grades 3 and 4)

1) This table shows the temperature and precipitation (rain or snow) in four different towns on the same day.

	Town A	Town B	Town C	Town D
Lowest Temperature	13°C	-9°C	22°C	-12°C
Highest Temperature	25°C	-1°C	30°C	-4°C
Precipitation (rain or snow)	0 cm	5 cm	2.5 cm	9 cm

Where did it snow?

- ☐ A) Town A
- ☐ B) Town B
- ☐ C) Town C
- ☐ D) Town D

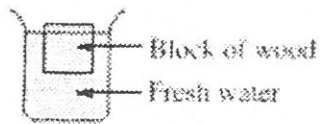
2) Which one of these refers only to living things?

- ☐ A) clouds, fire, rivers
- ☐ B) fire, rivers, trees
- ☐ C) rivers, birds, trees
- ☐ D) birds, trees, worms
- ☐ E) trees, worms, clouds

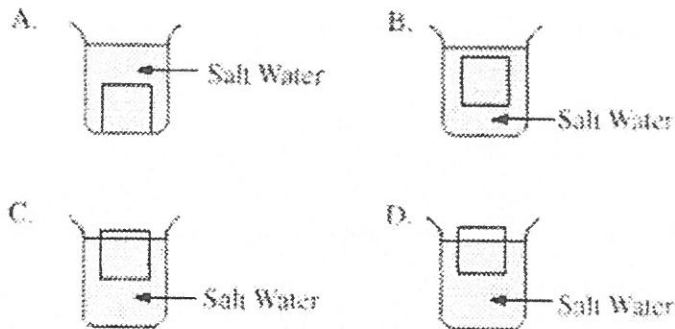
3) Your temperature is taken when you are NOT sick. Which temperature is CLOSEST to what the thermometer would show?

- ☐ A) 29°C
- ☐ B) 37°C
- ☐ C) 100°C
- ☐ D) 212°C

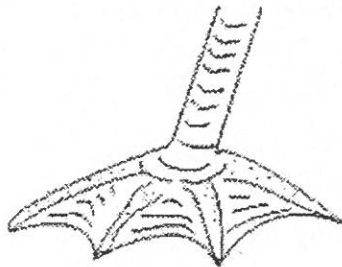
4) The picture shows a block of wood floating in fresh water.



If this block were placed in salt water from the ocean, which picture shows what would happen?



5) This is a drawing of a bird's foot..

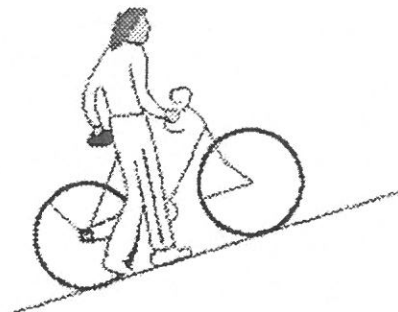


Where would you be MOST likely to find such a bird?

- ☐ A) forest
- ☐ B) meadow
- ☐ C) cornfield
- ☐ D) desert
- ☐ E) lake

6)

Keisha is pushing her bicycle up a hill. Where does Keisha get the energy to push her bicycle?

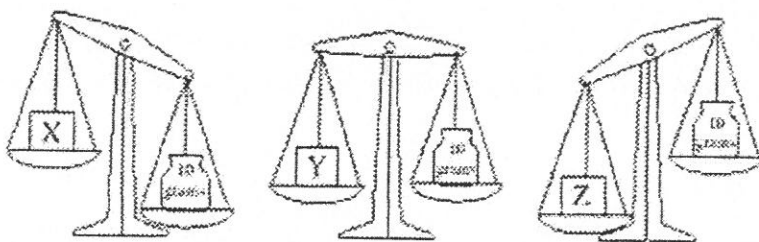


- A) From the food she has eaten
- B) From the exercise she did earlier
- C) From the ground she is walking on
- D) From the bicycle she is pushing

7) A powder made up of both white specks and black specks is likely to be

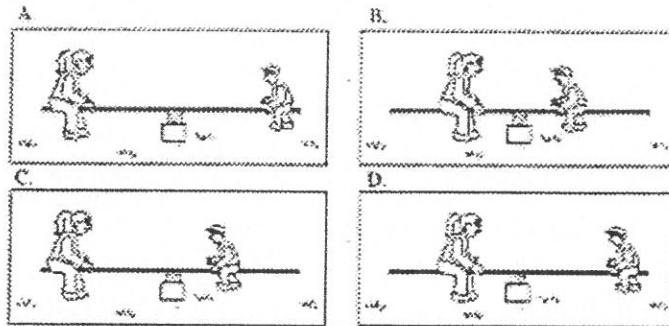
- A) a solution
- B) a pure compound
- C) a mixture
- D) an element

8) Which of the boxes X, Y, or Z has the LEAST mass?



- A) X
- B) Y
- C) Z
- D) All three boxes have the same mass.

9) A girl wanted to play on a seesaw with her little brother. Which picture shows the best way for the girl, who weighed 50 kg (kilograms), to balance her brother, who weighed 25 kg?



10) John kept some seeds on moist cotton in a dish. Mike put the same kind of seeds in a dish beside John's dish, and covered them with water. After two days, John's seeds sprouted, but Mike's did not.

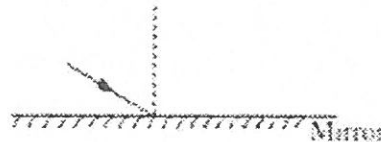
Which is the most likely reason?

- ☐ A) Mike's seeds needed more air.
- ☐ B) Mike's seeds needed more light.
- ☐ C) Mike did not put the dish in a warm enough place.
- ☐ D) Mike should have used a different kind of seed.

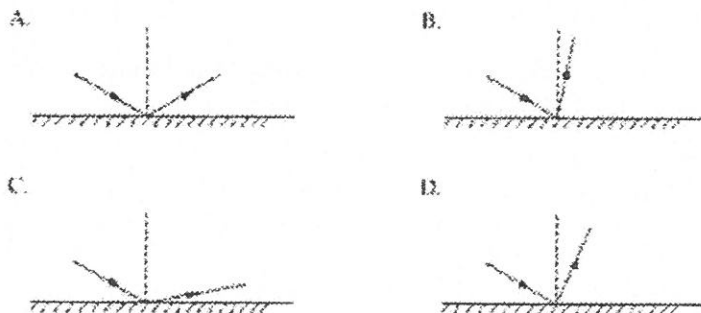
11) The Moon produces no light, and yet it shines at night. Why is this?

- ☐ A) The Moon reflects the light from the Sun.
- ☐ B) The Moon rotates at a very high speed.
- ☐ C) The Moon is covered with a thin layer of ice.
- ☐ D) The Moon has many craters.

12) A beam of light strikes a mirror as shown.



Which picture best shows what the reflected light would look like?



13) In a box there is a mixture of iron filings and sand. Which is the easiest way to separate the iron filings from the sand?

- A) Pour water on the mixture
- B) Use a magnifying glass
- C) Use a magnet
- D) Heat the mixture

14) Which is NOT used as an energy source?

- A) Flowing water
- B) Iron ore
- C) Sun
- D) Oil

15) To find out whether seeds grow better in the light or dark, you could put some seeds on pieces of damp paper and

- A) keep them in a warm, dark place
- B) keep one group in a light place and another in a dark place
- C) keep them in a warm, light place
- D) put them in a light or dark place that is cool

16) Which travels fastest?

- A) A train
- B) An airplane
- C) Sound
- D) Light

17) What is the BEST reason for including fruits and leafy vegetables in a healthy diet?

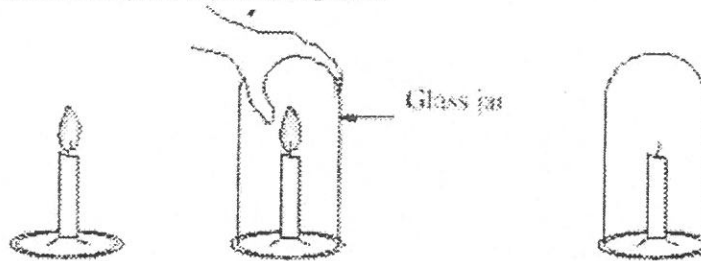
- A) They have a high water content.
- B) They are the best source of protein.
- C) They are rich in minerals and vitamins.
- D) They are the best source of carbohydrates.

18)

Some things were buried in wet ground. Several years later they were dug up. Which thing is MOST likely to have stayed the same?

- A) An egg shell
- B) A plastic cup
- C) A paper plate
- D) An orange peel

19) When a glass jar is placed over a lighted candle, the flame goes out.



Why does this happen?

- ☐ A) carbon dioxide is trapped in the glass
- ☐ B) the oxygen will be used up
- ☐ C) it gets too hot in the glass
- ☐ D) the wind makes it go out
- ☐ E) the glass makes it cold

20) Which picture does NOT show an insect?



21) Four children can feel and smell an object inside a bag, but they cannot see it. Which of the following is NOT an observation about the object?

- ☐ A) "It is flat at one end and round at the other."
- ☐ B) "It smells like peppermint."
- ☐ C) "It has a bump on it."
- ☐ D) "I hope it is candy."

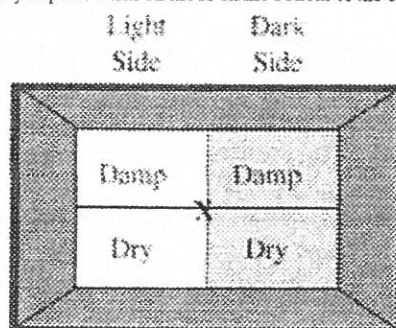
22) Ken put a thermometer in a glass filled with hot water. Why does the liquid inside the thermometer rise?

- A) Gravity pushes it up.
- B) Air bubbles are released.
- C) Heat from the water makes it expand.
- D) Air pressure above the water pulls it up.

23) Some children were trying to find out which of three light bulbs was brightest. Which one of these gives the best START toward finding the answer?

- A) One bulb looks brightest to me, so I already know the answer."
- B) All the bulbs look bright to me, so there cannot be an answer."
- C) It would help if we had a way to measure the brightness of a light bulb."
- D) We can take a vote and each person will vote for the bulb he or she thinks is the brightest."

24) Here is a picture of the inside of a box. If you put a worm on the X on the bottom of the box, to which corner would you expect it to go?



- A) Damp and light
- B) Dry and light
- C) Damp and dark
- D) Dry and dark

25) The Sun is bigger than the Moon, but they appear to be about the same size when you look at them from the Earth. Why is this?

- A) The moon shines only at night
- B) Because the sun is rotating
- C) The moon is closer to the earth
- D) The sun is higher up than the moon.

PHYSICS

AND

CHEMISTRY

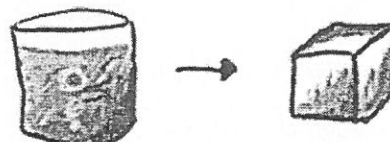
MATTER IS THE STUFF AROUND YOU

Matter is everything around you. Matter is everything made of atoms and molecules. Matter is anything that has a mass. Matter is also related to light and electromagnetic radiation. Even though matter can be found all over the universe, you usually find it in just a few forms. As of 1995, scientists have identified five **states of matter**. They may discover one more by the time you get old.

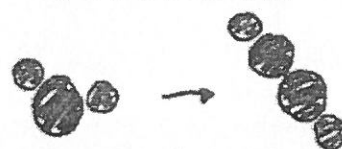
You should know about solids, liquids, gases, plasmas, and a new one called Bose-Einstein condensates. The first four have been around a long time. The scientists who worked with the Bose-Einstein condensates just received a Nobel Prize for their work in 1995. But what makes a state of matter? It's about the physical state of molecules and atoms.

Elements and compounds can move from one physical state to another and not change. Oxygen as a gas still has the same properties as liquid oxygen. The liquid state is colder and denser but the molecules are still the same. Water is another example. The **compound** water is made up of two hydrogen atoms and one oxygen atom. It has the same molecular structure whether it is a gas, liquid, or solid. Although its physical state may change, its chemical state remains the same.

So you ask, "What is a chemical state?" If the formula of water were to change, that would be a **chemical** change. If you added another oxygen atom, you would make hydrogen peroxide. Its molecules would not be water anymore. Changing states of matter is about changing densities, pressures, and temperatures. The basic chemical structure does not change.



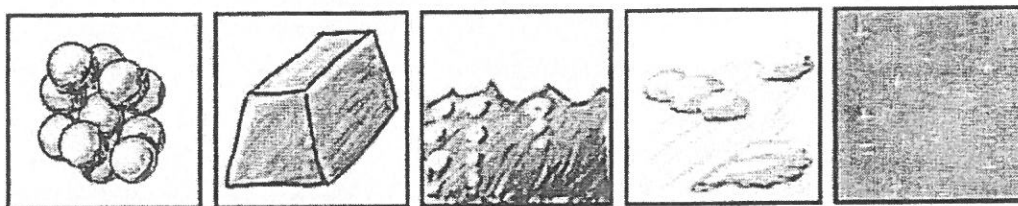
PHYSICAL CHANGE OF
WATER INTO ICE



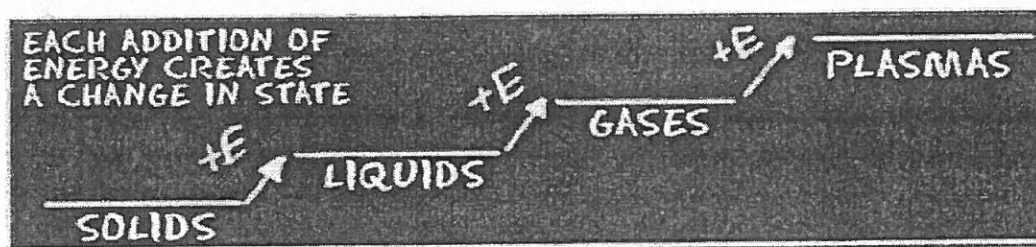
CHEMICAL CHANGE OF
WATER INTO
HYDROGEN PEROXIDE

STATES OF MATTER

There are five main states of matter. Solids, liquids, gases, plasmas, and Bose-Einstein condensates are all different states of matter. Each of these states is also known as a phase. Elements and compounds can move from one phase to another phase when special **physical forces** are present. One example of those forces is temperature. The phase or state of matter can change when the temperature changes. Generally, as the temperature rises, matter moves to a more active state.



Phase describes a physical state of matter. The key word to notice is physical. Things only move from one phase to another by physical means. If energy is added (like increasing the temperature or increasing pressure) or if energy is taken away (like freezing something or decreasing pressure) you have created a physical change.



One compound or element can move from phase to phase, but still be the same substance. You can see water **vapor** over a boiling pot of water. That vapor (or gas) can **condense** and become a drop of water. If you put that drop in the freezer, it would become a solid. No matter what phase it was in, it was always water. It always had the same chemical properties. On the other hand, a chemical change would change the way the water acted, eventually making it not water, but something completely new.

WHAT IS MATTER?

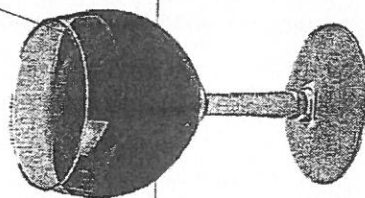
MATTER is all around us. Everything that exists in the universe is made up of matter – from the tiniest insect, to the distant stars in the night sky. Most matter is made up of minute particles called atoms. On Earth, matter usually occurs in one of three “states” (forms) called solid, liquid, or gas.

STATES OF MATTER

GAS

- A gas has no fixed volume or shape: it will expand to fill its container.
- Gas particles are widely spaced.
- Forces between the particles are very weak: particles move freely.

Every liquid takes the shape of its container

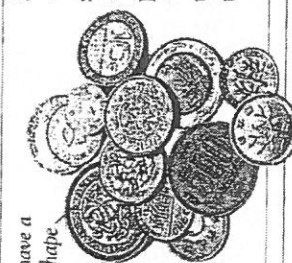


LIQUID

- A liquid has a definite volume but no fixed shape: it will flow and take the shape of its container.
- Liquid particles are more loosely bound than solid particles.
- Particles move short distances.

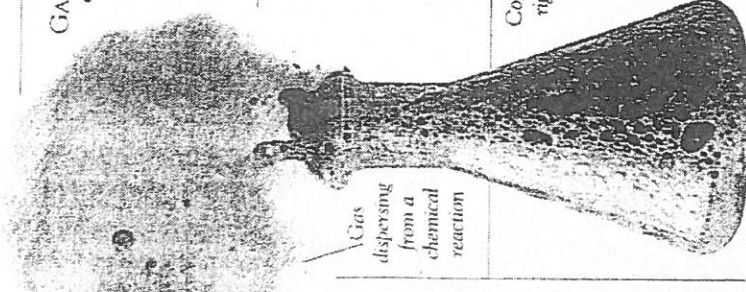
SOLID

- A solid has a fixed shape and volume.
- Solid particles are tightly packed in regular patterns.
- The particles can vibrate, though strong forces hold them firmly in place.



Coins have a rigid shape

Gas dispersing from a chemical reaction



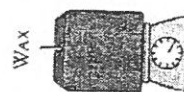
COMPARING MASS, DENSITY, AND VOLUME

MASS, DENSITY, AND VOLUME
Mass is the amount of matter in an object. Volume is the space the object occupies. An object's density is its mass divided by its volume. Density is used to compare the heaviness of different materials.

Blocks of equal mass but unequal density



LEAD
Density
11,300 kg/m³



WAX
Density
900 kg/m³

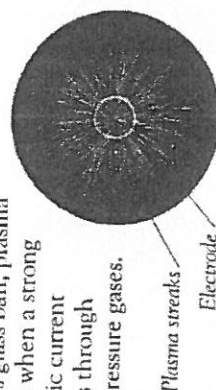


BALSA
Density
200 kg/m³

COMMON DENSITIES	
MATERIAL	DENSITY KG/M ³
Gold	19,300
Steel	7,900
Concrete	2,400
Water	1,000
Petrol	800
Wood (oak)	650
Air (at sea level)	1.025

PLASMA – THE FOURTH STATE OF MATTER

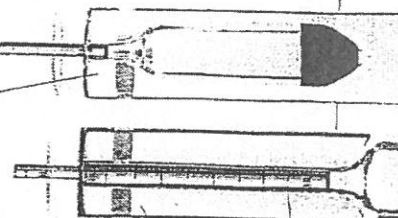
Plasma forms when electrons are torn from their atoms by electricity or heat. In this glass ball, plasma forms when a strong electric current passes through low-pressure gases.



Plasma streaks
Electrode

HYDROMETERS

A liquid's density is often given relative to the density of water. A hydrometer measures the relative density of liquids. The level at which the hydrometer floats indicates the density.



Cooking oil has a relative density of 0.91

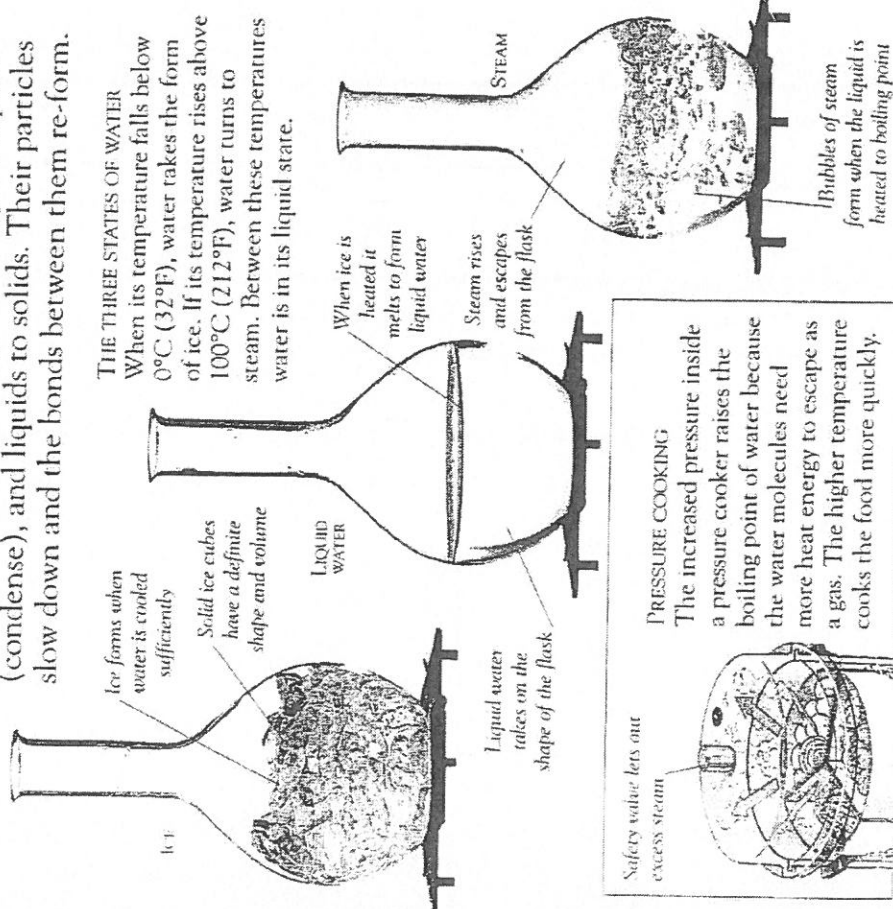
Hydrometer floats lower in oil

SI UNITS

The kilogram (kg) is the SI unit of mass. It is equal to the mass of a block of platinum alloy kept at Sèvres in France. There are 1,000 milligrams (mg) in a gram (g), 1,000 grams in a kilogram, and 1,000 kilograms in a tonne (t).

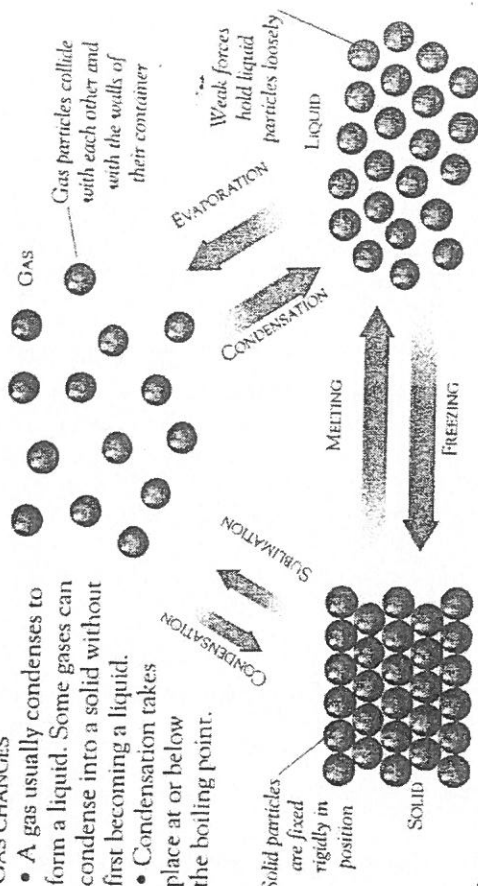
Changing state

The state of a substance is determined by its temperature. When heated, solids change to liquids, and liquids to gases because their particles vibrate faster, breaking the bonds that hold the particles together. When cooled, gases change to liquids (condense), and liquids to solids. Their particles slow down and the bonds between them re-form.



GAS CHANGES

- A gas usually condenses to form a liquid. Some gases can condense into a solid without first becoming a liquid.
- Condensation takes place at or below the boiling point.



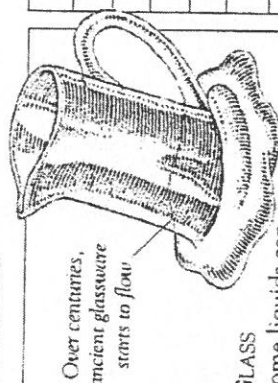
LIQUID CHANGES

- A liquid evaporates to form a gas. Above a temperature called its boiling point, all of the liquid becomes a gas.
- A liquid freezes to a solid below a temperature called its freezing point.

SOLID CHANGES

- Above a temperature called the melting point, most solids become liquids.
- Some solids can change directly into a gas without first becoming a liquid. This is sublimation.

MELTING/FREEZING POINTS	
SUBSTANCE	MELTING POINT
Alcohol (ethanol)	-169°C (-272°F)
Water	0°C (32°F)
Wax	57°C (135°F)
PVC	197°C (387°F)
Nylon	212°C (414°F)
Salt (sodium chloride)	801°C (1,474°F)
Gold	1,064°C (1,947°F)
Steel (stainless)	1,527°C (2,781°F)
Diamond	3,550°C (6,422°F)



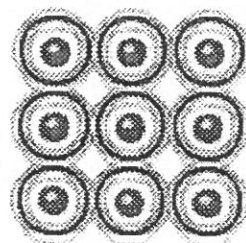
GLASS

Some liquids can be "supercooled" below their freezing point. They may stiffen and become glass. Particles in glass are arranged more randomly than those in normal solids.

SOLID BASICS

So what is a solid? Solids are usually hard because their molecules have been packed together. The closer your molecules are, the harder you are. Solids also can hold their own shape. A rock will always look like a rock unless something happens to it. The same goes for a diamond. Even when you grind up a solid into a powder, you will see little tiny pieces of that solid under a microscope. Liquids will move and fill up any container. Solids like their shape.

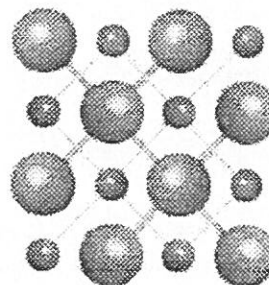
In the same way that a solid holds its shape, the atoms inside of a solid are not allowed to move around too much. This is one of the **physical** characteristics of solids. Atoms and molecules in liquids and gases are bouncing and floating around, free to move where they want. The molecules in a solid are stuck. The atoms still spin and the electrons fly around, but the entire atom will not change position.



Solids can be made up of many things. They can have pure elements or a variety of compounds inside. When you get more than one type of compound in a solid it is called a **mixture**. Most rocks are mixtures of many different compounds. Concrete is a good example of a manmade mixture.

CRYSTALS

On the other end of the spectrum from a mixture is something called a crystal. When a solid is made up of a pure substance and forms slowly, it can become a crystal. Not all pure substances form crystals because it is a delicate process. The atoms are arranged in a regular repeating pattern called a crystal lattice. A crystal lattice is a very exact organization of atoms. A good example is carbon. A diamond is a perfect crystal lattice while the graphite arrangement is more random.

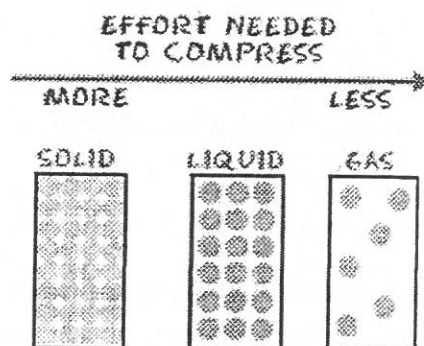


LIQUID BASICS

The second state of matter we will discuss is a liquid. Solids are hard things you can hold. Gases are floating around you and in bubbles. What is a liquid? Water is a liquid. Your blood is a liquid. Liquids are an in-between state of matter. They can be found in between the solid and gas states. They don't have to be made up of the same compounds. If you have a variety of materials in a liquid, it is called a solution.

One characteristic of a liquid is that it will fill up the shape of a container. If you pour some water in a cup, it will fill up the bottom of the cup first and then fill the rest. The water will also take the shape of the cup. It fills the bottom first because of **gravity**. The top part of a liquid will usually have a flat surface. That flat surface is because of gravity too. Putting an ice cube (solid) into a cup will leave you with a cube in the middle of the cup; the shape won't change until the ice becomes a liquid.

Another trait of liquids is that they are difficult to compress. When you compress something, you take a certain amount and force it into a smaller space. Solids are very difficult to compress and gases are very easy. Liquids are in the middle but tend to be difficult. When you compress something, you force the atoms closer together. When pressure goes up, substances are compressed. Liquids already have their atoms close together, so they are hard to compress. Many shock absorbers in cars compress liquids in tubes.

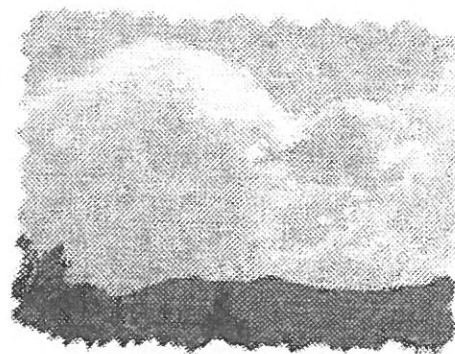


A special force keeps liquids together. Solids are stuck together and you have to force them apart. Gases bounce everywhere and they try to spread themselves out. Liquids actually want to stick together. There will always be the occasional evaporation where extra energy gets a molecule excited and the molecule leaves the system. Overall, liquids have **cohesive** (sticky) forces at work that hold the molecules together.

LOOKING FOR A GAS

Gas is everywhere. There is something called the atmosphere. That's a big layer of gas that surrounds the Earth. Gases are **random** groups of atoms. In solids, atoms and molecules are compact and close together. Liquids have atoms a little more spread out. However, gases are really spread out and the atoms and molecules are full of energy. They are bouncing around constantly.

Gases can fill a container of any size or shape. That is one of their physical characteristics. Think about a balloon. No matter what shape you make the balloon it will be evenly filled with the gas atoms. The atoms and molecules are spread equally throughout the entire balloon. Liquids can only fill the bottom of the container while gases can fill it entirely.



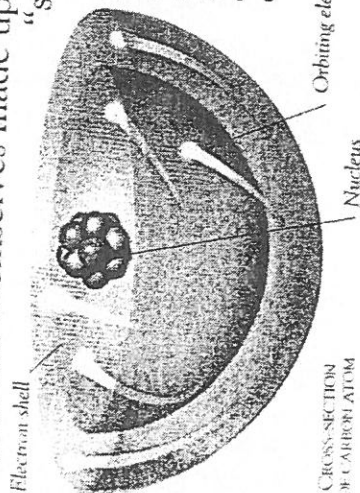
CLOUDS ARE ACTUALLY
LARGE AMOUNTS
OF WATER VAPOR.

You might hear the term **vapor**. Vapor and gas mean the same thing. The word vapor is used to describe gases that are usually found as liquids. Good examples are water or mercury (Hg). Compounds like carbon dioxide are usually gases at room temperature so scientists will rarely talk about carbon dioxide vapor. Water and mercury are liquids at room temperature so they get the vapor title.

Gases hold huge amounts of energy, and their molecules are spread out as much as possible. With very little pressure, when compared to liquids and solids, those molecules can be **compressed**. It happens all of the time. Combinations of pressure and decreasing temperature force gases into tubes that we use every day. You might see compressed air in a spray bottle or feel the carbon dioxide rush out of a can of soda. Those are both examples of gas forced into a space smaller than it would want, and the gas escapes the first chance it gets.

ATOMS

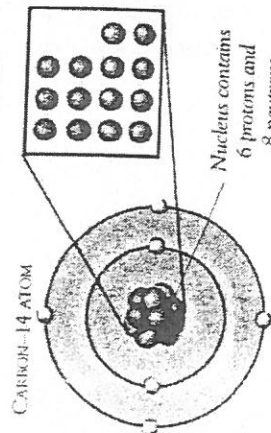
SOLIDS, LIQUIDS, AND GASES are made of tiny particles called atoms. Atoms are the building blocks for all the familiar materials around us, including our bodies. There are just over a hundred different types of atom, which are themselves made up of even smaller "subatomic" particles.



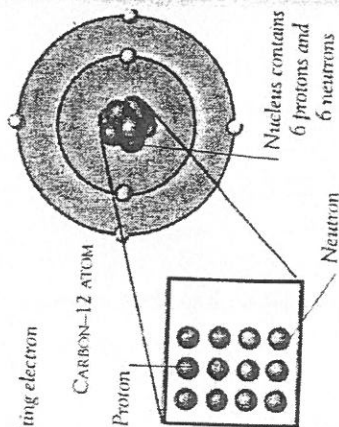
CROSS-SECTION OF CARBON ATOM

NUCLEON NUMBER

The total number of protons and neutrons in the nucleus is the atom's nucleon number. The most common form of carbon has 6 protons and 6 neutrons, so it is called carbon-12.



CARBON-14 ATOM



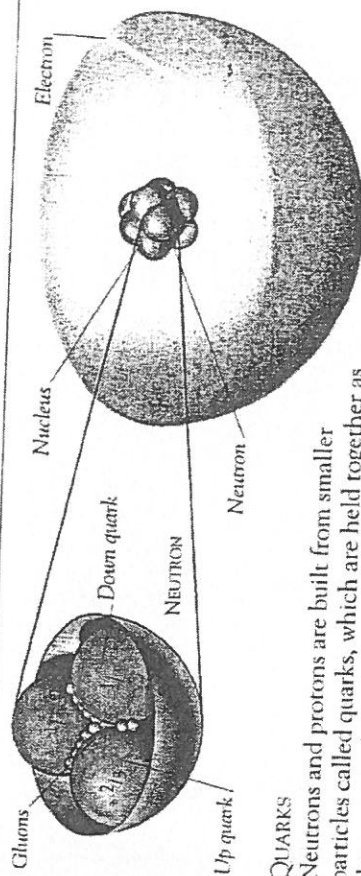
CARBON-12 ATOM

ISOTOPES

All atoms of the same element contain the same number of protons, but some forms of the element may have different numbers of neutrons. These are isotopes. The isotope carbon-14 has two more neutrons than the isotope carbon-12.

ATOMIC STRUCTURE

The centre, or nucleus, of an atom contains protons (which have a positive charge) and neutrons (which have no charge). Negatively charged particles called electrons orbit the nucleus in layers, or "shells".



QUARKS

Neutrons and protons are built from smaller particles called quarks, which are held together as they constantly exchange particles called gluons. "Down" quarks have one-third of a negative charge, and "up" quarks two-thirds of a positive charge.



PARTICLE COLLISIONS
Scientists discover new particles by smashing together subatomic particles at high speed. The collision briefly creates new particles, whose movements are recorded by computers.

DESCRIBING ATOMS

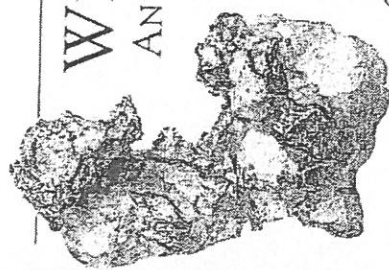
- The **relative atomic mass (RAM)** of an element compares the average mass of its atoms to the mass of a carbon-12 atom.
- An element's **atomic number** tells you the number of protons in the nuclei of its atoms.

ATOM FACTS

- An electron is 1,836 times lighter than a proton, and 1,839 times lighter than a neutron.
- Over 200 different types of subatomic particle are known.
- Specks of dust contain a million million atoms.

RELATIVE ATOMIC MASS (RAM)

ELEMENT	SYMBOL	RAM
Hydrogen	H	1.008
Carbon	C	12.01
Sodium	Na	22.99
Iron	Fe	55.85
Bromine	Br	79.90
Tungsten	W	183.9
Mercury	Hg	200.6



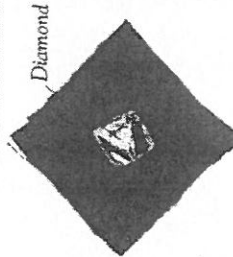
VEINS OF PURE GOLD IN QUARTZ

WHAT ARE ELEMENTS?

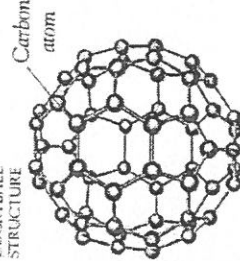
AN ELEMENT IS a substance made of only one type of atom. Of the 114 known elements, 89 occur naturally on Earth. The rest are made artificially. A few "unreactive" elements, such as gold, occur in their pure state; most form compounds with other elements.

ALLOTROPES OF CARBON

ALLOTROPES
Allotropes are different physical forms of the same element. The different arrangement of their atoms gives them different appearances and properties.



Diamond

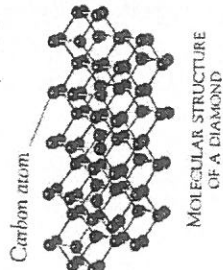
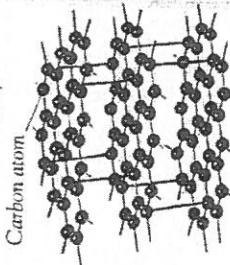


BUCKMINSTERFULLERENE
The molecules of this newly discovered carbon allotrope have 60 atoms linked in a sphere. It is called a "buckyball".



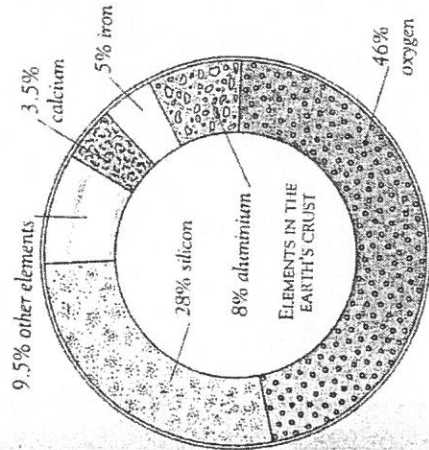
Graphite

GRAPHITE
The atoms form huge sheets. Only weak bonds link the sheets together. Graphite is soft because the sheets can slide over each other easily.



DIAMOND
Each atom links strongly to four others in a rigid, compact framework that stretches throughout the diamond. This makes the diamond extremely hard.

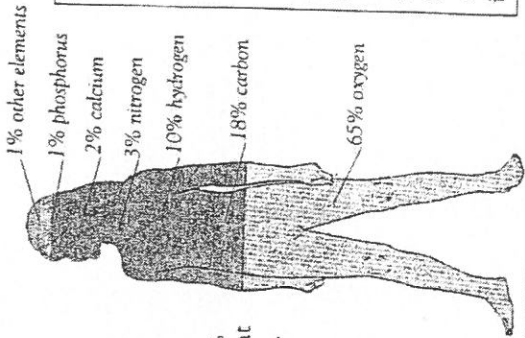
COMPOSITION OF THE EARTH'S CRUST
The bulk of the Earth's crust is oxygen and silicon, mostly combined in rocks or sand (silicon dioxide). Clays are made of silicon and oxygen combined with the third most common element - aluminium.



SIMPLEST AND MOST ABUNDANT
Hydrogen and helium, the simplest elements, were the first to form after the Big Bang created the universe. Hydrogen and helium make up 97% of the mass of stars, and are by far the most abundant elements in the universe.



BODY ELEMENTS
The tissues of your body are made up of hydrogen, oxygen, carbon, and nitrogen, while bones contain calcium. Together, these five elements account for 98% of your body mass. Elements such as copper, iron, and zinc occur only in tiny amounts, but these "trace" elements are vital for good health.



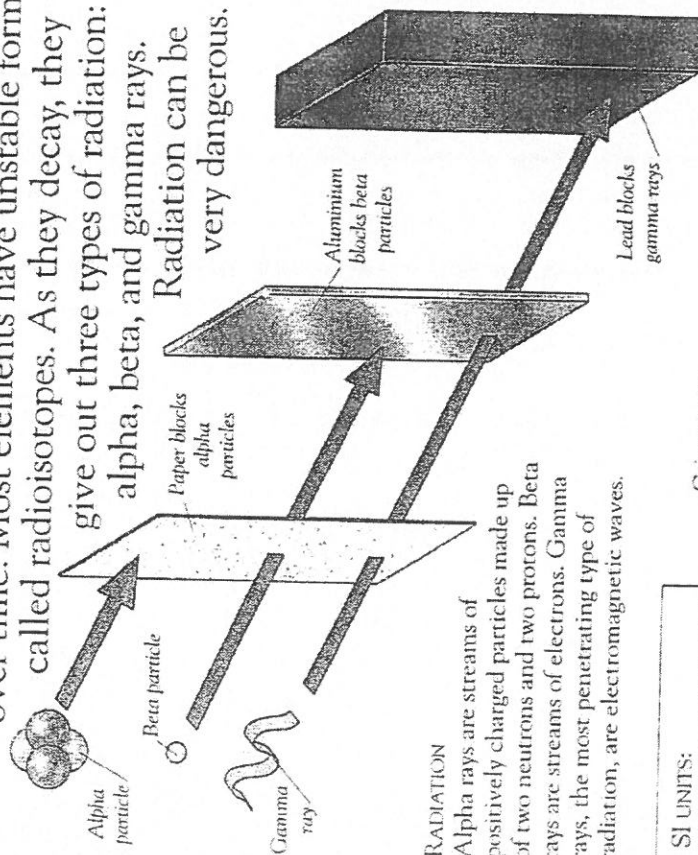
Over 50% of your body mass is water

ELEMENT FACTS

- Ancient Greek philosophers believed there were just four elements: earth, fire, air, and water.
- Astatine is the rarest element on Earth; the rarest metal is rhodium.
- Technetium was the first element to be made artificially.
- Earth's atmosphere is 78% nitrogen.

RADIOACTIVITY

THE NUCLEI OF some atoms are radioactive. This means they are unstable and will decay (break up) over time. Most elements have unstable forms called radioisotopes. As they decay, they give out three types of radiation: alpha, beta, and gamma rays. Radiation can be very dangerous.

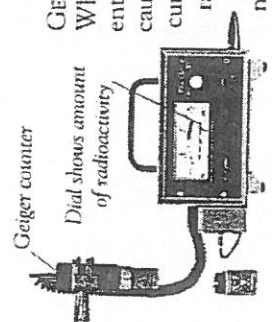


RADIATION

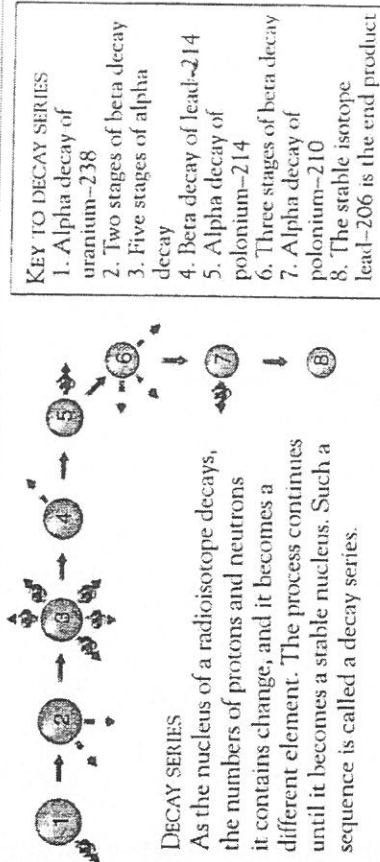
Alpha rays are streams of positively charged particles made up of two neutrons and two protons. Beta rays are streams of electrons. Gamma rays, the most penetrating type of radiation, are electromagnetic waves.

SI UNITS:

The becquerel (Bq) is the unit of radioactivity. The radioactivity of a substance measured in becquerels is the number of its nuclei that decay each second.



GEIGER COUNTER
When a radioactive particle enters a Geiger counter, it causes a brief pulse of electric current to flow. The radioactivity of a sample is calculated by the number of these pulses.



DECAY SERIES

As the nucleus of a radioisotope decays, the numbers of protons and neutrons it contains change, and it becomes a different element. The process continues until it becomes a stable nucleus. Such a sequence is called a decay series.

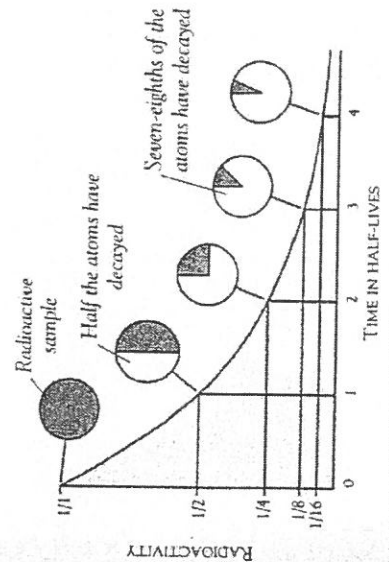
RADIOACTIVE HALF-LIVES

The time taken for half of the nuclei in a radioactive substance to decay is called the substance's half-life. Over each half-life period, radioactivity falls first to a half, then to a quarter, and so on. The half-life of each radioisotope is different.

HALF-LIVES OF RADIOISOTOPES		
ISOTOPE	HAIF-LIFE	TYPE OF DECAY
Uranium-238	4,500 million years	Alpha
Carbon-14	5,570 years	Beta
Cobalt-60	5.3 years	Gamma
Radon-222	4 days	Beta
Unnilquadium-105	32 seconds	Gamma

RADIOACTIVITY FACTS

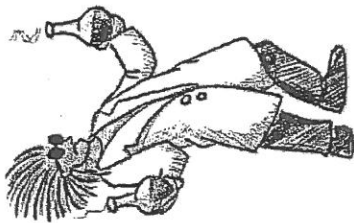
- Though radiation can be dangerous, it has many uses in medicine, including sterilizing equipment and killing cancer cells.
- Radioactivity was discovered by the French physicist Antoine Henri Becquerel in 1896.



HY-DRO-GEN

Let's start our tour of the periodic table with hydrogen. Why start with hydrogen? Hydrogen is the first element in the **periodic table** and the most basic and common of all elements in the universe. Over ninety percent of all the atoms in the universe are hydrogen atoms and they are the lightest of all elements.

Although it has been around forever, it took a chemist named Lavoisier to name it. The name hydrogen comes from the Latin word "hydro" which means water. Lavoisier knew that hydrogen was in all water molecules. Scientists use the letter "H" to represent hydrogen in all chemical equations and descriptions.



1	ATOMIC NUMBER -number of electrons -number of protons	SYMBOL/NAME	ATOMIC MASS -in AMU (atomic mass units)
1		H	1.01

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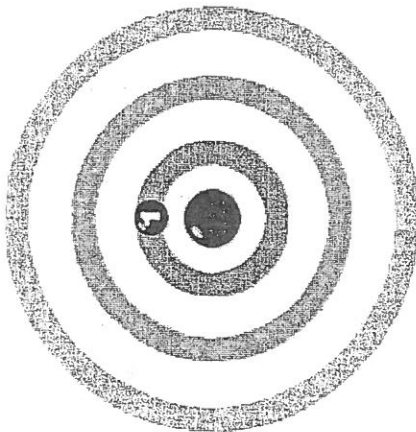
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So... for the element of HYDROGEN, you already know that the **atomic number** tells you the number of electrons. That means there is only one electron in a hydrogen atom. Looking at the picture, you can see there is only one electron in shell one.

21



THE SUN

Hydrogen is very easy to burn. As you know, the Sun is one big ball of fire. One of the elements that makes the sun burn so brightly is hydrogen.

WELDING AND BLOWTORCHES

Sometimes you see someone working with a blowtorch, or welding something together. They use gases that can burn very hot and make a bright flame. One of those gases is hydrogen.

PLANTS AND SUGARS

Hydrogen is in all plants. There are sugars all throughout plants and there is hydrogen in sugar. That's why animals eat plants... For the sugar and the energy.

CRYOGENICS

Hydrogen is used in something called cryogenics. Cryogenics is a process when scientists freeze things. When hydrogen is in a liquid form it is very, very cold. Scientists use this cold hydrogen to freeze things very quickly.

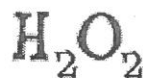
WATER

This is a water molecule. Even though you find complex names on other molecules, everyone calls H_2O Water. Water is made up of two hydrogen (H) atoms and one oxygen (O) atom. The formula for water is H_2O . The Hydrogen atoms have filled orbitals with two electrons and the oxygen atom is filled with eight electrons.



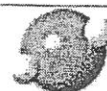
HYDROGEN PEROXIDE

Two hydrogen atoms can also bond with two oxygen atoms, making the formula H_2O_2 . That's just one more oxygen than water but it is a totally different compound. You can see that each of the Oxygen atoms has eight electrons and the two Hydrogens have two electrons each. See how the electrons are shared?



HYDROGEN SULFIDE

Two hydrogen atoms can also bond with one sulfur atom and make the compound H_2S (also known as **Hydrogen sulfide**). The same way that oxygen is happy when it has two extra electrons, sulfur (S) likes to have two extras as well. See how the Sulfur atom gets to share each of the electrons from the Hydrogen atoms?

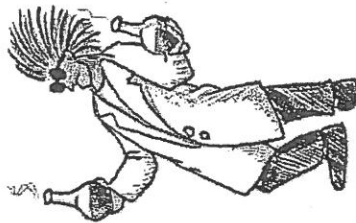


CAR-BON

This is the magic element for everything on Earth. All life on Earth depends on carbon. It is in nearly every biological compound that makes up our bodies, systems, organs, cells, and organelles. When you breathe out, it's carbon combined with oxygen. Carbon has been known and used for thousands of years.

Carbon is the sixth element in the periodic table. Located between boron and nitrogen, it is a very stable element. Because it is stable, it can be found in many naturally occurring compounds and by itself. Scientists describe the three states of carbon as **diamond**, **amorphous**, and **graphite**.

It was never really discovered. Ancient people knew of the black soot left over after a fire. That was carbon.



6	ATOMIC NUMBER - number of electrons - number of protons
C	SYMBOL/NAME
12.01	ATOMIC MASS - in AMU (atomic mass units)

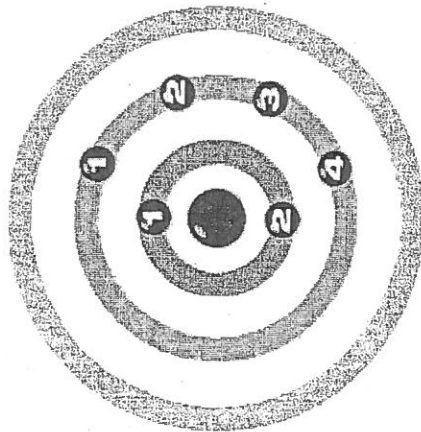
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So... for the element of CARBON, you already know that the **atomic number** tells you the number of electrons. That means there are 6 electrons in a carbon atom. Looking at the picture, you can see there are two electrons in shell one and four electrons in shell two.



PLANTS

All plants have carbon as their most important element. Without carbon plants would not exist. That means every animal on Earth also needs carbon to survive. You can't just eat carbon, it needs to be in plants before humans can do anything with it.

DIAMONDS

When you see a diamond it is one big chunk of carbon. After a very long time and carbon is left in a very high pressure area, all of the atoms are pushed together to form a crystal. That crystal is called a diamond.

CHARCOAL

The next time your family goes to a barbecue you'll know that the main ingredient of the charcoal is carbon. Carbon compounds store lots of energy and is good at holding onto heat. That's why it's used for charcoal.

GRAPHITE

Take a look at your pencil. The black stuff you write with is made of carbon. It is a special type of carbon called graphite.

PETROLEUM PRODUCTS

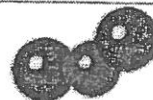
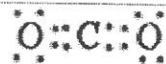
Next time you're at the gas station you can know that carbon is the most important part of gasoline. Gasoline is made up of oil and oil is created from the plants which died millions of years ago. You know there is carbon in plants... That means there is carbon in oil and gasoline.

PLASTICS

Everything that is plastic has carbon in it. We just talked about gasoline. Like gasoline, plastic things are made from oil. That means carbon is also the most important element plastic.

CARBON DIOXIDE

This is a **Carbon dioxide** molecule. When you breathe out, you usually breathe out Carbon dioxide. With the formula CO_2 that means there are two oxygen atoms and one carbon atom. If you look closely at the dot structure, you'll see that they share four electrons each. If a bond shares two electrons that means it is a single bond. If a bond is made up of four electrons it is a double bond. That means that the Carbon atom has two double bonds, one with each Oxygen atom.

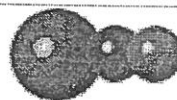


CYANOGEN CHLORIDE

Here's something new! We have three different elements here, carbon, nitrogen, and chlorine. That's not special, but the way they combine is! Look at the carbon and the nitrogen, they are sharing six electrons!

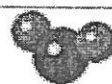
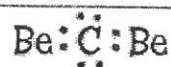
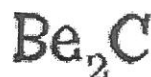
When two atoms share two electrons, that's a single bond. If they share four it's a double bond. Well these two are sharing six, that's a triple bond. It's extremely strong and powerful. It would take a lot of work to separate the C and the N!

One more thing! Because the bond between carbon and nitrogen is so strong, scientists call them **Cyanogen** instead of carbon-nitrogen. Scientists know that **Cyanogen** is always **CN**.



BERYLLIUM CARBIDE

Two beryllium atoms are able to bond with one carbon atom. The beryllium atoms let the carbon use their electrons so that the carbon is "happy". Each Beryllium gives up both of its two extra electrons to the Carbon. Take a look and see how all of the electrons are shared.

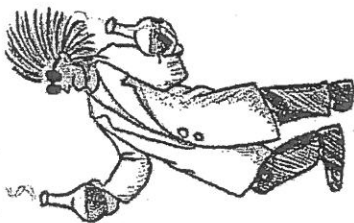


OX-Y-GEN

You're breathing right now and your body is taking in its needed oxygen molecules. You need oxygen to survive, as do all other living organisms. It's a good thing that oxygen makes over twenty percent of the Earth's **atmosphere**. We are the only planet in the solar system with enough oxygen available to let us survive.

Did you know that if you breathe too much oxygen you could die? What about this? If you have a room filled with oxygen and hydrogen and someone lit a match... It would explode! That's because oxygen is very **reactive**.

Oxygen is the eighth element of the **periodic table** and found in the second row (period). Alone, oxygen is a colorless and odorless compound that is a gas at room temperature. Oxygen molecules are not the only form of oxygen in the atmosphere; you will also find oxygen as **ozone** and **carbon dioxide**. A chemist named Priestly isolated oxygen in 1774.



8	ATOMIC NUMBER - number of electrons - number of protons	O	SYMBOL/NAME	16.00	ATOMIC MASS - in AMU (atomic mass units)
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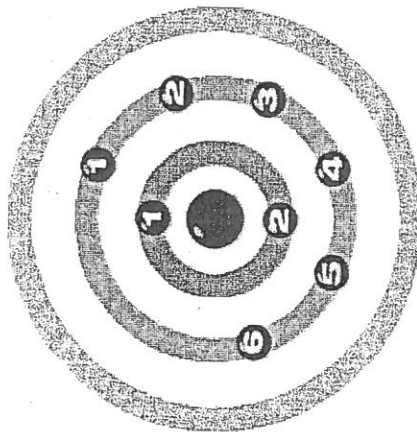
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So... for the element of **OXYGEN**, you already know that the **atomic number** tells you the number of electrons. That means there are 8 electrons in an oxygen atom. Looking at the picture, you can see there are two electrons in shell one and six in shell two



OZONE LAYER

In the past couple of years you may have heard of something called ozone. It is a compound that floats in the atmosphere around the Earth. Did you know that ozone is made up of oxygen? That's right. Three oxygen atoms can combine and make ozone.

PLASTICS

Oxygen is inside things made out of plastic. Every time you get a 2-liter bottle or a yogurt, look at the plastic. Now you know there is oxygen inside all plastics.

BREATHABLE AIR

Oxygen is very important. Life on Earth could not exist without it. Animals need to breathe oxygen to survive. Luckily, there is enough oxygen in the air for everyone to breathe.

ROCKS AND SOILS

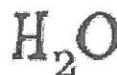
You just read that there is oxygen in the air. Here's something else... 50% of the Earth's crust is made up of oxygen. That means that no matter what you pick up or dig up from the ground... There's a good chance that one half of it is made up of oxygen.

WATER

Over half of the Earth is covered with water. Mixed in that water is oxygen. In the same way we breathe the oxygen in the air, fish breathe the oxygen in the water.

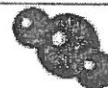
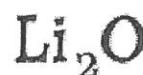
WATER

This is a water molecule. Even though you find complex names on other molecules, everyone calls H_2O , Water. Water is made up of two hydrogen atoms and one oxygen atom. The formula for water is H_2O . The Hydrogen atoms have filled orbitals with two electrons, and the oxygen atom is filled with eight electrons.



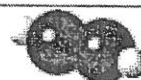
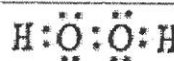
LITHIUM OXIDE

Two lithium atoms can bond with one oxygen atom, making the formula Li_2O . Oxygen likes to have two additional electrons to make it happy. Each Lithium atom provides one. You can see that the Oxygen atom has eight electrons (6 of its own, and one from each Lithium), and the two Lithium atoms have two electrons each.



HYDROGEN PEROXIDE

Two hydrogen atoms can also bond with two oxygen atoms, making the formula H_2O_2 . That's just one more oxygen than water, but it is a totally different compound. You can see that each of the Oxygen atoms has eight electrons, and the two Hydrogens have two electrons each. See how the electrons are shared?

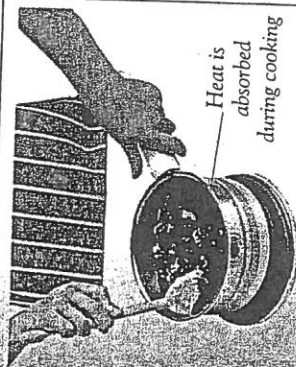
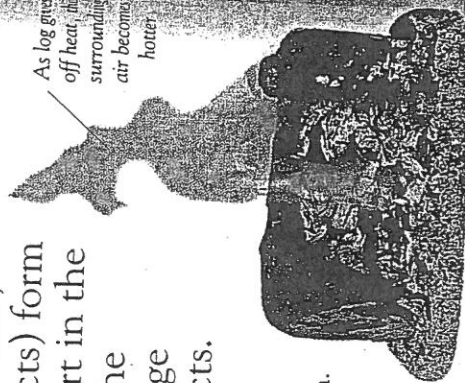


CHEMICAL REACTIONS

WHEN A CHEMICAL reaction occurs, new substances (called products) form from the substances taking part in the reaction (called reactants). The atoms of the reactants rearrange themselves to form the products.

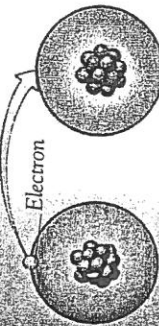
EXOTHERMIC REACTIONS

Burning is an exothermic reaction – more heat is given out during the reaction than is taken in. Oxidation occurs when a substance combines with oxygen. When a log burns, it combines with oxygen and gives out heat. Reduction occurs when a substance loses oxygen.



ENDOTHERMIC REACTIONS

Some reactions take in more heat energy than they give out. These reactions are called "endothermic". When a reaction takes place during cooking, it is endothermic.

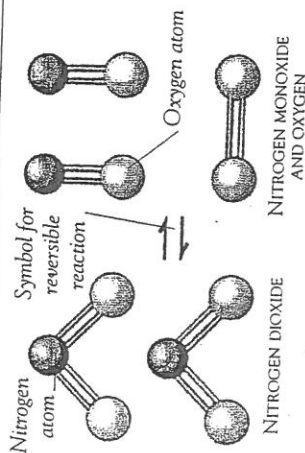


ELECTRON TRANSFER

During the oxidation process, atoms lose electrons and are "oxidized". During reduction, atoms gain electrons and are "reduced".

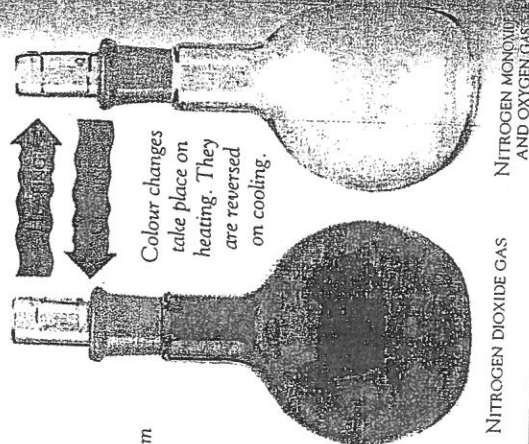
ACTIVATION ENERGY

Most reactions need some energy to get them started. This energy is called activation energy. Striking a match gives it the energy to ignite.



REVERSIBLE REACTIONS

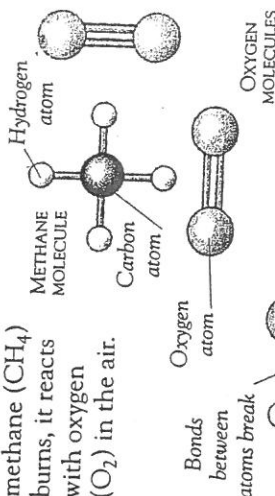
Reversible chemical reactions can go forwards and backwards. When heated, nitrogen dioxide (NO_2) breaks down into nitrogen monoxide (NO) and oxygen (O_2); when cooled, the change is reversed.



MAKING AND BREAKING BONDS

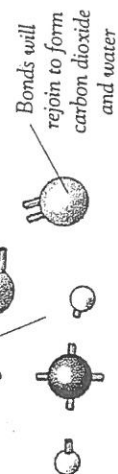
1 DURING A CHEMICAL REACTION

Energy is taken in when chemical bonds are broken, and it is released when new bonds are formed. When methane (CH_4) burns, it reacts with oxygen (O_2) in the air.



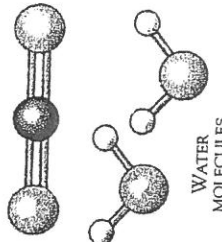
2 BROKEN BONDS

During the reaction, all the bonds between the atoms are broken. New bonds form as the atoms join up in different combinations.



3 NEW BONDS FORM

The reaction produces carbon dioxide (CO_2) and water (H_2O). The new bonds have less stored energy than the original ones, so the reaction gives out energy as heat.



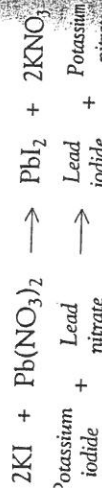
www.chemtutor.com/react.htm

Describing reactions

Each element has a chemical symbol to identify it, and each compound a chemical formula. The formula indicates how the elements in the compound are combined. A chemical equation shows which substances react together during a chemical reaction and the products that result.

CHEMICAL EQUATIONS ALWAYS BALANCE

No atoms are lost during a chemical reaction, so its chemical equation must balance, with equal numbers of atoms of each element on either side. Here, lead nitrate solution reacts with potassium iodide solution. The chemical equation for this reaction is shown below.



Potassium iodide + Lead nitrate → Lead iodide + Potassium nitrate

Sodium is high in the activity series, and reacts violently with air

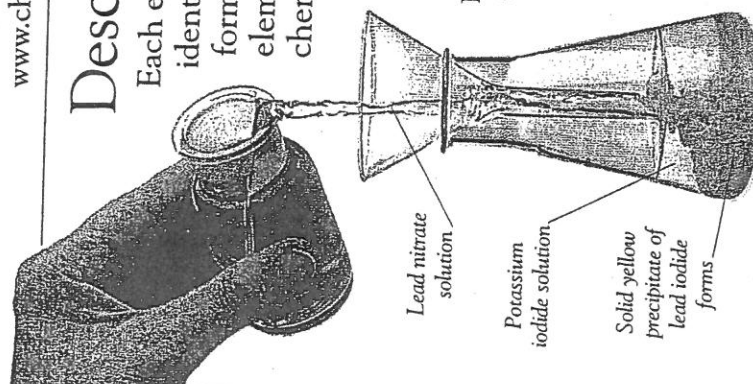
Potassium Sodium Calcium Magnesium Aluminium Zinc Iron Lead Copper Mercury Silver Platinum Gold

THE ACTIVITY SERIES

The activity series compares the reactivity of different metals – that is, how readily they form compounds with other substances. Elements at the top of the series are highly reactive. Those at the bottom are very unreactive. Highly reactive metals cannot be found uncombined in nature.

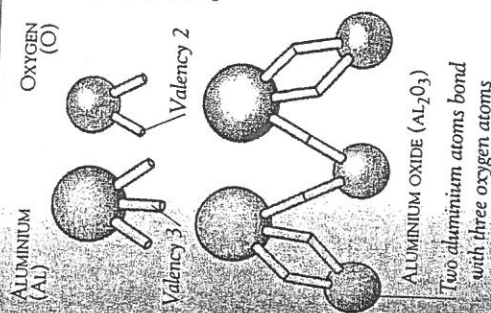
REACTION FACTS

- No mass is lost during any chemical reaction – this was first noted by French chemist Antoine Lavoisier in 1774.
- Caesium is the most reactive metal element.
- The present system of using letters to represent elements was devised in 1811.



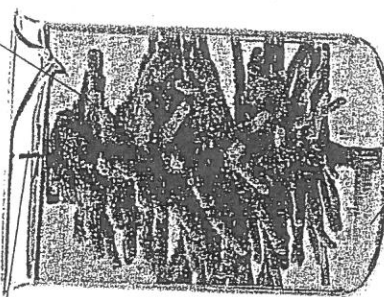
VALENCY

An atom's valency shows the number of chemical bonds it can form. It is the number of electrons the atom gains, loses, or shares when it makes bonds. When a compound has formed, the total valencies of the different atoms involved will be the same.



DISPLACEMENT

A metal will displace (put out of place) a less reactive metal from a solution. Here, atoms from a "tree" of copper wire displace silver atoms from a clear solution of silver nitrate. The copper turns the solution blue, while the displaced silver forms crystals on the wire.



SUFFIXES AND PREFIXES		
SUFFIX	DESCRIPTION	EXAMPLE
-ide	Contains just the two elements in the name	Iron sulphide (FeS)
-ite	Contains oxygen as well as the other elements in the name	Iron sulphite (FeSO ₃)
-ate	Contains more oxygen than -ites	Iron sulphate (FeSO ₄)
PREFIX	EXAMPLE	ATOMS IN PREFIX
Mono-	Carbon monoxide (CO)	1
Di-	Nitrogen dioxide (NO ₂)	2
Tri-	Boron trichloride (BCl ₃)	3

SI UNITS

The mole (mol) is a measure of the number of atoms, molecules, or ions in any substance.

- 1 mole contains 6 x 10²³ particles. This number is called Avogadro's constant, after Italian scientist Amedeo Avogadro.

Although the number of particles in one mole of any element is the same, their masses vary due to different-sized nuclei.

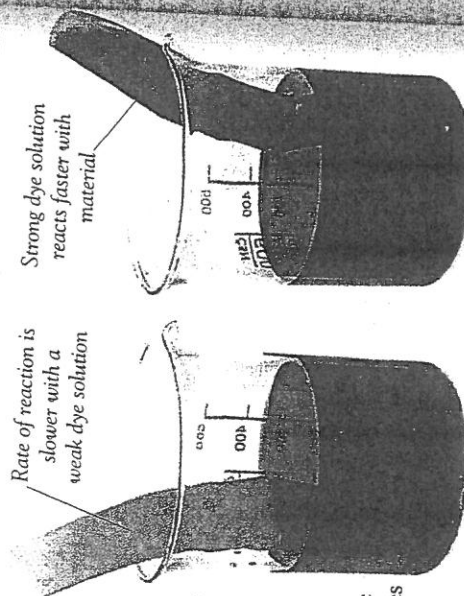
A mole of copper has a mass of 64 g, a mole of aluminium 27 g.

Controlling reactions

Chemists speed up reactions by making the reacting particles collide with each other more often or with greater energy. Substances called catalysts speed up reactions by helping substances react together. They remain unchanged by the chemical reaction.

Rate of reaction is slower with a weak dye solution

Strong dye solution reacts faster with material

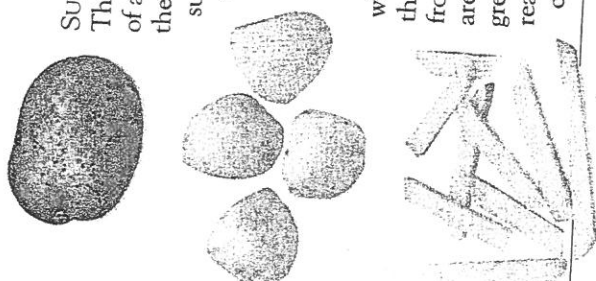


CONCENTRATION

Increasing the concentration of a reactant speeds up a reaction. Dyeing a material is faster with a concentrated dye - there are more dye molecules to collide with the material.

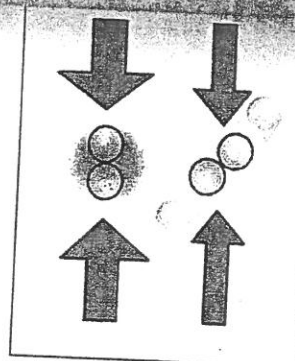
SURFACE AREA

The surface area of a solid object is the size of its outer surface. Increasing the surface area of a reacting substance speeds up a chemical reaction. This is why chips fry faster than the potato from which they are made. The chips' greater surface area reacts with the hot cooking oil.



COLLISION THEORY

When particles collide, they usually bounce harmlessly off each other. But if the particles collide with enough force or energy, the bonds holding them together break, and a chemical reaction takes place.



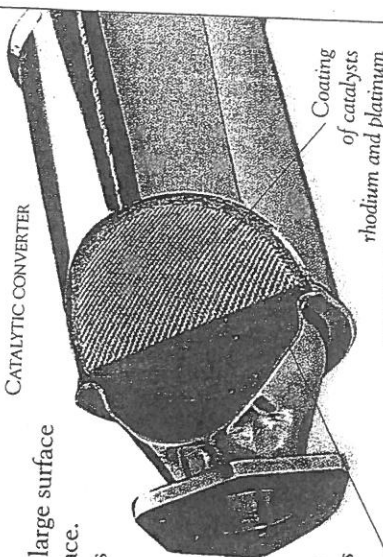
CATALYSTS IN INDUSTRY

PROCESS	REACTANTS	CATALYST
Manufacture of ammonia	Hydrogen and nitrogen	Iron and iron(III) oxide
Manufacture of nitric acid	Ammonia and oxygen	Platinum
Manufacture of sulphuric acid	Sulphur dioxide and oxygen	Vanadium(V) oxide
Manufacture of margarine	Vegetable oil and hydrogen	Nickel or platinum
Manufacture of methanol	Methane and oxygen	Chromium(III) oxide or zinc oxide

CATALYTIC CONVERTER

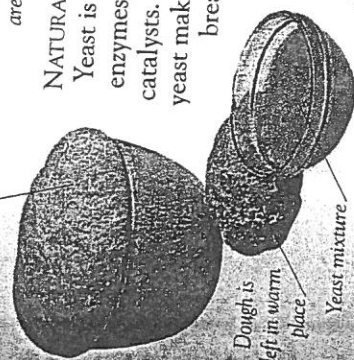
A car's catalytic converter provides a large surface area for chemical reactions to take place. Harmful gases formed when fuel burns are forced into close contact with catalysts in the converter. The substances react together to produce less harmful gases. The catalysts are unchanged by the reaction.

CATALYTIC CONVERTER



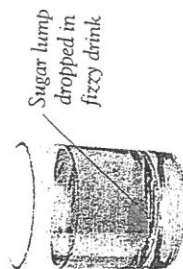
NATURAL CATALYSTS

Yeast is a fungus containing enzymes, which are biological catalysts. The enzymes in yeast make starches and sugars break down more rapidly into carbon dioxide gas and ethanol. In bread making, yeast helps the dough to rise.



MORE REACTION FACTS

- Raising temperature or pressure increases the rate of reaction.
- The human body contains over 1,000 different enzymes.
- Biodegradable plastics decompose faster in strong sunlight.



SUGAR AS A CATALYST
Sugar makes a fizzy drink fizz harder. It acts as a catalyst for the dissolved carbon dioxide gas to come out of the solution.

Quiz Name: Science - Atoms

Type: Multiple Choice (static answer order)

Instructions: Select the correct answer from the choices listed.

1.

Every kind of matter is made up of _____. Circle Answer

stuff
chemicals
atoms

2.

An electron has a _____ charge. Circle Answer

positive
negative
neutral

3.

A proton has a _____ charge. Circle Answer

positive
negative
neutral

4.

A neutron has a _____ charge. Circle Answer

positive
negative
neutral

5.

A proton has about the same mass as a _____. Circle Answer

nucleus
neutron
electron

6.

Protons and neutrons are found in the _____ of an atom. Circle Answer

circle
electron
nucleus

7.

Electrons are 1,800 times smaller than _____. Circle Answer

protons
neutrons
nuclei
protons and neutrons

8.

The center of an atom is called the _____. Circle Answer

protons
neutrons
nucleus
inner circle

9.

The _____ move in space around the nucleus of an atom. Circle Answer

neutrons
electrons
protons
leptons

10.

The letters _____ can help you remember the three subatomic particles. Circle Answer

pip
pep
pen
pel
lep

(27)

CHEMISTRY / PHYSICS (PART 01)
VOCABULARY & SCIENTIFIC TERMS
 (INCLUDING THE GENERAL KNOWLEDGE QUIZ)

THE TERMS GIVEN *IN ITALICS* NEED A DEFINITION/ DESCRIPTION/ EXAMPLES!

PRECIPITATION	
SALT	
A SOLUTION	
A MIXTURE	
TO BALANCE	
TO SPROUT	
TO REFLECT	
A CRATER	
A MAGNIFYING GLASS	
IRON ORE	
A PROTEIN	
AN EGG SHELL	
A GLASS JAR	
<i>AN INSECT</i>	
TO EXPAND	
TO FLOAT	
TO PUSH	
A PURE COMPOUND	
<i>AN ELEMENT</i>	
A SEED	
TO SHINE	
TO COVER	
A BEAM OF LIGHT	
FLOWING WATER	
A WATER CONTENT	
A CARBOHYDRATE	
AN ORANGE PEEL	
A FLAME	
GRAVITY	
AIR PRESSURE	
<i>STATES OF MATTER</i>	
<i>SOLIDS/ LIQUIDS/ GASES</i>	
A MOLECULE	
<i>A PHYSICAL CHANGE</i>	
<i>A CHEMICAL CHANGE</i>	
A CHEMICAL STRUCTURE	
ADDITION/ TO ADD	
<i>WATER VAPOR/ STEAM</i>	
ENERGY	
TO CREATE	
THE UNIVERSE	
TINY	
A PARTICLE	
TO OCCUR	

VOLUME	
SHAPE	
TO MOVE FREELY	
TO VIBRATE/ A VIBRATION	
TO FLOW	
A CONTAINER	
DEFINITE/ FIXED	
A DISTANCE	
TIGHTLY PACKED	
A REGULAR PATTERN	
A FORCE	
MASS	
DENSITY	
TO OCCUPY	
TO DIVIDE STH BY STH	
TO COMPARE	
HEAVINESS	
COMMON	
STAINLESS STEEL	
CONCRETE	
PETROL	
RELATIVE DENSITY	
A UNIT	
AN ALLOY	
AN ICE CUBE	
TO HEAT	
TO ESCAPE	
A BUBBLE	
CONDENSATION	
SUBLIMATION	
MELTING	
EVAPORATION	
FREEZING	
A BOILING POINT	
A FREEZING POINT	
A MELTING POINT	
TO FILL UP	
FLAT (ADJ)	
A SURFACE	
TO COMPRESS	
COHESIVE FORCES	
RANDOM	
A CONTAINER	
CARBON DIOXIDE	
TO SPIN	
A CRYSTAL LATTICE	
GRAPHITE/ DIAMOND	
CARBON	
A NUCLEUS	
A PROTON	
A NEUTRON	
AN ELECTRON	

NUCLEON NUMBER	
A QUARK	
MERCURY	
HYDROGEN	
IRON	
ISOTOPEs	
ALLOTROPES	
AN ARRANGEMENT	
A PROPERTY	
TO LINK	
A MOLECULAR STRUCTURE	
THE EARTH'S CRUST	
ALUMINIUM	
CALCIUM	
SILICON	
NITROGEN	
HELIUM	
PHOSPHORUS	
ABUNDANT	
TO SURVIVE	
AN ATMOSPHERE	
TO BREATHE (IN/OUT)	
THE PERIODIC TABLE	
COLORLESS = COLOURLESS	
ODORLESS = ODOURLESS	
OZONE	
ATOMIC NUMBER	
ATOMIC MASS/ AMU	
OZONE LAYER	
THE FORMULA (FOR WATER)	
LITHIUM OXIDE	
HYDROGEN PEROXIDE	
TO PROVIDE	
A CHEMICAL EQUATION	
TO SHARE	
SULFUR = SULPHUR	
HYDROGEN SULFIDE = HYDROGEN SULPHIDE	
WELDING	
CRYOGENICS	
TO EXIST	
TO SURVIVE	
CHARCOAL	
AN INGREDIENT	
TO STORE	
GASOLINE	
A SINGLE/DOUBLE BOND	
A TRIPLE BOND	
POSITIVE/ NEGATIVE CHARGE	